

HOW TO WRITE A LAB OR

# Science Report

**T**HE PURPOSE OF THIS GUIDE is to help you learn to write student-level reports of laboratory research, also known as scientific reports or *lab reports*. Although we will discuss some differences between professional and student-level lab reports, our main focus is helping you complete and understand those you will do at a high school level. However, even as a student you might discover that one of your reports is worthy of publication in scientific journals, if you follow good scientific method and the suggestions we provide in this guide. After all, a number of successful scientists first published the results of their research when they were in high school or even earlier (e.g., **Louis Agassiz**, the paleontologist, **Jean Piaget**, the psychologist, and **Terence Tao**, the mathematician).

### How lab reports differ from term papers.

Lab reports differ in several ways from term papers (also sometimes called “research papers”) that you complete for other classes.

### Main goals: Communicate clearly and answer the key questions.

At the student level, your main goal for a lab report should be to communicate clearly to your instructor what you did and observed in your study (or experiment), as well as what the results mean. (We will refer broadly to any form of data collection as a “study,” encompassing both direct forms of data collection such as experiments, as well as indirect observational or “qualitative” studies often conducted in the social sciences.) Some of the key questions an instructor might ask you in determining your level of understanding include:

**Do you have a clearly stated objective or hypothesis?**

**Do you present the data in a clear and concise fashion?**

**Are you able to interpret the results of the study?**

**Can you account for any discrepancies in your results?**

**Do you present a thoughtful conclusion?**

**Do you understand the overall relevance of the findings from the study?**

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## Sections

The lab report answers such questions in a formal and structured way. You will usually follow the following sequence in actually writing your lab report, but note that the abstract (if you include it) will come first among these elements in the final report:

### Introduction

Provides background information (e.g., previous studies) and includes the objectives and the hypothesis.

### Method

Specifies the details of your study, including information about any participants, materials, or measurement devices used; procedures; and specialized statistical or related analytic tools. In other words, how did you do it?

### Results

Reports the data and analyses based on the data. States whether the results were consistent with the hypotheses, usually without interpretation of any wider meaning or importance. What did you find?

### Discussion

Interprets the results of the experiment in terms of wider meaning and importance. What do the results mean?

### References

List of works used to write the lab report.

### Appendix (or Appendices)

Addendum of raw data, charts, graphs, or any information that was not easily included in the body of the lab report.

### Abstract

(Optional; as your instructor requests) Provides a summary of the lab report and is placed at the report's beginning.

Your instructor may require variations of this framework or use different terminology. For example, the Method section might also be called "Materials and Methods," "Methodology," or "Experimental." The framework we present here has evolved over the past few hundred years in the history of science, and even today is neither universal nor the only "correct" way to structure a lab report, but is certainly more commonly used.

## Tips to get you started

## Writing a Lab Report

### Websites of Interest

We have identified a number of Web sites offering information about writing lab reports.

### References

#### HOW LAB REPORTS DIFFER FROM TERM PAPERS

THE SKILLS REQUIRED for writing student-level lab reports and term papers are much the same, and most of the processes required are identical. We will highlight some of the differences, however, to help define the overall goal of lab reports.

**Lab reports generally require less time for background research.** For a lab report, you really only need to present the reader with enough background information to provide a rationale for the hypothesis and the particular tests used in the study. Of course, this distinction only holds true for student-level lab reports; professional lab reports often require a great deal of time searching through library and Web-based research reports. The Web has made it much easier to complete background research for lab reports.

**Lab reports emphasize standardized and clear presentation of information.** Where the lab report places relatively less importance on library and Web-based research than a research or term paper, it places greater emphasis on clear descriptions and following standardized formats in the structure of the report. Ultimately, the lab report “should enable readers to replicate the experiment so that they can verify the results for themselves” (*Beer, 1997*).

Despite these differences, both the lab report and the term paper should follow basic rules of good writing and research.

#### INTRODUCTION

Your introduction describes why the question you are investigating is important. In your introduction, you generally provide a provisional answer to the question in the form of a prediction, usually referred to as a hypothesis. You will introduce the important concepts, mathematical relationships, and any definitions that are relevant to the study described in the following sections. As with the rest of the report, your writing should be clear, concise, and easy to understand.

#### Your introduction should answer these questions:

**What is the nature of the study?**

**What is the objective of the study?**

**What background information is necessary for the reader?**

**What particular method was used to conduct the study? Why?**

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Briefly summarize the background information you have collected through library and Web-based research. Include only the references that provide the most relevant information. From reading this section, your instructor should be able to quickly understand the nature of the study and why you are conducting it.

Typically, the introduction is written in present tense and follows a narrative form.

### METHOD

**D**EPENDING ON YOUR instructor's preferences, you may need to refer to this section as "Material and Methods," "Experimental," "Procedures," or "Methodology."

The **subsections** you should include depend on the specific features of your study. Here are the subsections most frequently included in student-level Method sections:

**Sample**—If your study includes human participants, describe them in this first subsection. Delete this subsection if your study does not examine humans.

**Experimenters**—If the characteristics of the experimenters in your study are likely to affect its results, you should include this section to describe the experimenters, who are the people collecting the data. Provide enough description to allow someone else to match the characteristics of your experimenters if he or she tries to duplicate or replicate the findings of your study. Most reports do not include an experimenters section; this section is more common in research in the social sciences.

**Materials (and measures)**—This subsection describes all nonhuman materials or organisms used in your study. This is a broad category and includes any substances, instruments, or apparatus used in the experiment. The presentation of this section should be chronological. Depending on the complexity of the tools you use to measure the results of your study, you may also need to include a special subsection on "Measures." This is especially true if your study hinges on the quality of specific measures used. If your study focuses on plants or animals, you would probably describe them in the materials section; however, your instructor may wish to see any live materials set apart in a "sample" section.

**Procedures**—This subsection focuses on techniques and procedures used in the experiment. This includes all steps necessary for someone to recreate your experiment, and—if all goes well—to reproduce your results.

**Analyses**—This subsection is included only if you will be using complex or less commonly used analytic methods, such as new statistical methods with which your instructor may not have great familiarity. It informs your instructor of the particular method behind the data analysis you will describe in the next section of the lab report.

In a nutshell, the Method section should describe what materials you used and what you did with them (*Lobban, 1992*). You should include the type of equipment, technology, and amounts of different compounds used, and so on. Although you should not describe every detail of your process, you need to explain how you set up the study in enough detail for a reader to repeat or replicate it. You should also include any details that will affect the outcome of the study. Include a description of any anomalies that you found in the study. Be exact and specific in your descriptions. For example, if the study took place in an environment at room temperature, do not

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simply write, “the experiment was undertaken at room temperature.” Instead, note the exact temperature of the room.

Ask your instructor exactly how detailed your Method section should be. Although you might simply need to follow a lab manual or handout that includes a detailed description of the materials and methods of your study, your instructor may want you to rewrite the entire procedure, rather than just cite the lab manual. Furthermore, your instructor may have modified a study that you are following from a published manual. You should note these modifications. You must also record any differences from the lab manual that you or your lab partner(s) made during the study.

Keep in mind that this section is very important. In order for your work to be of scientific merit, you must provide enough information for your reader to be able to reproduce your methods. If you do not give your reader enough detail, others will find it impossible to repeat or replicate your study, which will make any results you report suspect.

### Writing Tips for the Method Section

Unless your study is extremely simple, or you are otherwise instructed, use subsections with their own headers (e.g., write “Materials” on the left margin and underline, then start the materials subsection with a new paragraph).

You may find it convenient to itemize items within the subsections in a list format. For example, you could include “the exact technical specifications and quantities and source or method of preparation” (*Day, 1998*). However, your instructor may also prefer that you write everything out.

In all sections, but especially in the procedures subsection, avoid using the word “then” repeatedly, as in, “then I added the sulfur compound, and then I stirred, and then I looked at the result.” Instead, write in chronological order, so the “then” is understood.

Never use ambiguous words like “maybe” or “often” or “sometimes.” Be explicit and accurate. Try to quantify the information that you present as much as possible. This ensures that the reader will be able to replicate the experiment.

Usually the Method section is written in past tense.

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### RESULTS

**I**N THIS SECTION, you present the data that you collected and recorded during your study. Your task is to report the findings clearly and accurately, but you do not want to elaborate on the “meaning” or “interpretation” of these results. You will do that in the next section, **Discussion**.

You should use proper units of measurement and be clear and concise to avoid misinterpretation. Include all of your calculations and formulas. Define new symbols and other pertinent information. Make sure your calculations are organized and sequential, use proper units, and are clearly labeled.

If you determined only a few results (whether qualitative or quantitative), then include and describe them within the body of the text. If your study is complex, with many variables, or if for any reason the results are too complex to describe easily through the body of the text, present them in tables or figures. However, you will still need to refer to the graphs and identify or highlight the key findings in the body of the text. In other words, the reason you provide the tables and figures is to communicate clearly to the reader, who will rely on your text to help him or her make the most sense out of the tables and figures.

**Tables.** Tables include columns and rows in which you organize information. Any data that cannot be appropriately conveyed in a few simple lines within the text of the lab report should be presented in a table. You can include very large tables of raw data in an **Appendix**.

In your written report, present large tables on separate pages. Each table requires a title and each column of data should be clearly labeled.

**Figures and Graph.** Figures in lab reports are the remaining “catch-all” category, and can include graphs, scatterplots of data points, and—less frequently—drawings and even photographs. Essentially, figures are pictures of things. Our discussion will focus on the use of graphs, but there may be times when you need to include other types of figures in your report.

The type of graph that you will draw (if applicable) depends on the type of data that you have collected. Continuous data involves the relationship between two factors, and requires a line graph (see Figure 1). In other words, if the objective of the study is to demonstrate whether a relationship exists between two variables, you should use a line graph.

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Discrete data, such as the number of humans being studied within a particular group, requires a histogram or bar graph (see Figure 2).

In a line graph, plot the independent variable along the x-axis (horizontal) and the dependent variable on the y-axis (vertical).

### **Definitions: Independent and Dependent variables.**

Independent variables are variables that presumably effect other variables. In experiments, you purposefully change or manipulate independent variables to test whether this effects another variable of interest, which is the “dependent” variable because its value depends (or is thought to depend on) the independent variable.

### **Results**

Once you have prepared the appropriate tables, graphs, and figures, you can begin writing the Results section. State the results briefly. Describe the overall results in a narrative manner. You don't need to describe each separate measurement, except when you come across particularly unusual data that you wish to highlight.

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Try to resist the temptation to explain the meaning of your results; save it for the next section.

Add the tables and figures (remember, graphs are called “figures”), and consecutively number all tables as tables, and all figures as figures. In other words, if you have first two tables followed by a figure, then a table, then another figure, the names for them would be Table 1, Table 2, Figure 1, Table 3, and Figure 2.

Avoid redundancy. Do not simply repeat the data that is listed in the tables and figures.

Finally, as with the Method section, Results section is usually written in the past tense.

### DISCUSSION

**Y**OU ADDRESS THE importance and meaning of the results in the Discussion section. It is appropriate to address the following questions in this section:

**Do the results support the objective of your experiment?**

**Do the results support or refute your hypothesis (or hypotheses), your original predictions?**

**Are the results consistent with those reported by other investigators?**

**If the results were not as expected, or deviated somewhat from what was expected, what are some possible explanations?**

**Are there any potential threats to your conclusions caused by your methods? What limitations in your study provide opportunities for future investigators to improve on or extend your investigation?**

**If your study disproves a theory or part of a theory, can you recommend changes in real world practices that exist because the theory was assumed to be true?**

The Discussion section usually begins with your interpretation of the data. In particular, did the findings reported in the results section refute or fail to refute the hypothesis (or hypotheses)? A key issue here is whether you really tried to disprove hypotheses in your study, or were instead—as is usually the case with student-level research—merely trying to verify theoretical relationships already “known.”

Professional-level researchers often try to disprove theories through elaborately designed studies, or—more commonly—sets of studies. They can spend years at the effort. As a student researcher, don’t expect to disprove widely accepted theories or “laws.” Even when your data are inconsistent with established theory, it is likely to be the case that some error in method, or analysis or interpretation of the data, may be the culprit. Then again, perhaps you really did uncover something interesting, and unexpected, that will make others take notice! This is part of what makes science interesting to scientific researchers.

At any rate, now you see why it is so important to completely and accurately record what you do in the Method and Results sections. If you do happen to disprove an established theory, or make an otherwise interesting discovery, other researchers will immediately seek to repeat what you did and verify your interpretations. If the theory says there is a positive correlation between two

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variables, and you did not observe it in your study, you will need to admit any potential limitations in your study that might produce such lack of correlation. For example, you might say: “The observed lack of theoretically predicted correlation between the two variables may have arisen due to several factors, including...”

However, it is important not to panic if your study results do not conform to those predicted by theory. First, the theory could in fact be wrong, and if your results are inconsistent with even established theory you must believe it is plausible that the theory is wrong. To do otherwise would be intellectually dishonest. However, to be intellectually fair, you must also identify sources of possible error in your methods and analyses.

In your discussion of the potential limitations of your study, you must report any problems with the materials you used, errors in calculation and methodology (you should always try to correct those before turning in your report, however), and anything else that might have altered the results of the experiment. If you can do this, you will still do well on the lab report, despite the fact that you may have obtained unexpected results.

End your discussion section by summarizing your conclusions. Relate these conclusions back to your introduction. Also, consider how the results of your study, or at least research of this sort, may be of practical benefit in the world. This will be easier to address if the line of research has obvious applications to help people or yield improved products or services; however, even seemingly “pure” research may suggest potential practical benefits down the line. Use your imagination to uncover the possible applications, which may of course be (reasonably) speculative.

Again, be concise, clear, and straightforward. There is no need for fancy language. Creative writing will not cover up the fact that you did not understand the significance of the experiment.

The discussion section should be written in the past tense when it refers to the study and the results you found. However, you may need to write in the present and even the future tense when discussing implications for current and future theory, practice, and any expectations you have for your next steps in research.

## REFERENCES

A LIST OF REFERENCES is a list of sources that you actually cited in your lab report. Because a lab report does not require much original research, your instructor is likely to ask for a list of references rather than a more extensive bibliography. Ask to make sure. A bibliography is different from a list of references, because it includes a list of relevant or important works that you consulted in order to write your lab report, but *did not cite*.

Citations are important. First, you want to give credit through citation in order to avoid plagiarism. Also, appropriate citations make your report more scholarly and prove to your instructor that you took the time to consult other works.

Remember to check (and double-check) all the information in your references. To be complete in your report, you must check your reference information against the original source; if you don't, at least note the source where you obtained the reference (“cited in...”). It is wise to add references to your reference list as you write your report, but also remember to check through the

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completed report and verify that you have included a reference for all works cited. You will also want to delete those references from your reference list (but not a bibliography, if you include one) that you do not actually cite.

References are generally arranged in alphabetical order by the authors' last names, but this will depend on which citation style your teacher wants you to use.

### Citation Style

There are numerous citation styles from which to choose. Some widely used options:

**The Chicago Manual of Style (1993)**

**The MLA Handbook for Writers of Research Papers (Gibaldi, 1999)**

**The Publication Manual of the American Psychological Association (1994).** We generally follow American Psychological Association (APA) citation style in this Research Guide.

**The ACS Style Guide (Dodd, 1986)** from the American Chemical Society

**A Manual for Writers of Terms Papers, Theses, and Dissertations (Turabian, 1996)**

### Citation of Electronic Source

Information is increasingly available on the Web and through other electronic sources, e.g., the Internet, CD-ROMs, direct e-mail from researchers and research centers, and so on. When you cite a Web site, use a citation style appropriate to electronic sources. There are different styles available for citing electronic sources, so ask your instructor for his or her preferred style. Many of the traditional sources of citation style listed above (e.g., *Gibaldi, 1999*; *APA, 1994*) also provide guidelines for citing electronic sources. You may also turn to *Walker and Taylor (1998)* and others (*Hale & Scanlon, 1999*; *Li & Crane, 1996*; *Library of Congress, 1999*), which focus exclusively on electronic usage and citation.

## APPENDIX (OR APPENDICES)

**T**HIS SECTION SHOULD be added only if needed. Generally, you will add an appendix when there is too much data to include in the results section, but when this data is needed to make the report complete. This might include raw data, tables, charts, or figures. However, many professional-level scientific reports follow a different practice; where material is not essential for the basic report (e.g., raw data, extensive tables, and so on), many authors simply ask the reader to contact the author for the additional information. Even in that case the author treats the additional information as if it were an appendix, and it is therefore good practice even at the professional level to prepare these appendices at the time one completes the basic report.

## ABSTRACT

**A**SK YOUR INSTRUCTOR whether you should include an abstract with your lab report. An abstract is a one-paragraph summary or synopsis of the entire lab report. Include the abstract at the very beginning of the lab report, and set it apart by writing the word "Abstract" above this section, and then somehow show that the introduction begins immediately afterward.

Remember that the abstract is an overall summary of your entire report, and should not serve as an introductory paragraph; that is the purpose of the introduction!

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The abstract must also be able to stand on its own, so don't make any statements that require further explanation or that reference an issue you raise in the body of your paper. Do not include references to your own lab report (e.g., to tables and graphs) or to literature citations. (In some professional scientific journals there are exceptions to this rule, but for student-level reports you should not include such references.)

Write the abstract so that it makes sense to a reader who hasn't read the rest of your report. In the opening sentence(s) of the abstract, you should state the purpose of the experiment. In the subsequent sentence(s), you should briefly describe the methods used to obtain the results and tests of any hypotheses. In the body of the abstract, you should note whether or not the hypotheses were rejected (and the implications of such) and other important findings from the study. End with your overall conclusions. If there is time and room, mention the "real world" practical applications of what you discovered through your research.

### Tips To Get You Started

**Be confident. Don't panic.** Even if this is your first lab report, you should do well if you follow the general framework, write clearly and concisely, and convey to your instructor that you understand the study.

**Just start it.** Take one step at a time, and you will reach your goal. The main thing is to begin and to persevere. Begin by completing a draft of each section in the order presented in this guide—namely: Introduction, Method, Results (and associated tables and figures), Discussion, References (although keep adding to your references as you cite them), Appendix (optional), and Abstract (if your instructor requires it). Also add a title page if your instructor requests one. After completing a draft of all sections, you can then revise them as needed.

**Don't delay** writing notes on what you have done, especially for the Method and Results sections. It is too easy to forget the specific methods you used, or if any odd events occurred during your study that might have effected the results.

**Use a Research Notebook.** There is no such thing as "down time" while you are completing your study. During the period when you are completing your introduction, you may have a good idea when you are eating breakfast. Write it down in your notebook.

*While you are collecting data, there may be times when you are waiting for a particular reaction to occur. Use that time to think and write. Jot down notes in your notebook. You can also use such a notebook for recording hypotheses, notes from articles or Web sites, or drafting paragraphs to add to your various sections. Most professional-level researchers maintain such notebooks that form the "raw material" for their reports, and such notebooks can also help you as a student.*

### WEBSITES OF INTEREST

#### Citing references using major styles:

**Writer's Workshop, University of Illinois, Urbana-Champaign; covers APA, and MLA.**  
<http://www.english.uiuc.edu/cws/wworkshop/bibliostyles.htm>

**Citing Electronic Sources, Library of Congress.**  
<http://memory.loc.gov/ammem/ndlpedu/resources/cite/index.html>

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### Sites on writing lab reports.

**Writing a Laboratory Report, by Deborah Mowshowitz, Director of Undergraduate Program and Laboratories, Columbia University.**

[http://www.columbia.edu/cu/biology/faculty/mowshowitz/howto\\_guide/lab\\_report.html](http://www.columbia.edu/cu/biology/faculty/mowshowitz/howto_guide/lab_report.html)

**Laboratory Reports, Engineering Communication Centre, University of Toronto.**

<http://www.ecf.utoronto.ca/~writing/handbook-lab.html>

**Laboratory Notebook and Lab Report Writing (chemistry orientation).**

<http://chemlabs.uoregon.edu/Classes/Exton/Misc/reports.html>

**Writing and Typing Instructions for Lab Reports (psychology orientation).**

<http://www.oswego.edu/~klatsky/apasg.htm>

**A Guide for Writing Research Papers**

<http://webster.commnet.edu/mla.htm>

### General writing help

**Writing Resources on the Web, Undergraduate Affairs, Massachusetts Institute of Technology.**

<http://web.mit.edu/uua/www/writing/links/>

### Scientific organizations, styles of writing across sciences

**Scholarly Societies project, University of Waterloo Library.**

<http://www.lib.uwaterloo.ca/society/overview.html>

**Scientific Organizations, American Association for the Advancement of Science.**

<http://www.aaas.org/spp/dspp/so.htm>

### Research notebooks

**Research Notebooks, Media Lab, Massachusetts Institute of Technology.**

<http://www.cs.indiana.edu/mit.research.how.to/section3.6.html>

**Doing Research: Notebooks, Virginia Polytechnic and State University.**

<http://ei.cs.vt.edu/~cs5014/fall.95/courseNotes/WebPages/6.ResearchProcess/abrams148.htm>

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### Reporting statistical methods and information

**Statistics and Statistical Graphics Resources, York University.**

<http://www.math.yorku.ca/SCS/StatResource.html>

### Scientific visualization

**Graphics and Visualization Links.**

<http://www.csc.fi/visualization/links.html>

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### Science fairs

How to develop your lab report into a sustained project that can lead to educational and career opportunities.

**The Science Fair Page, Houston Public Library and the Houston Independent School District.**

[http://www.hpl.lib.tx.us/youth/science\\_fair\\_index.html](http://www.hpl.lib.tx.us/youth/science_fair_index.html)

**Your Science Fair Project Research Guide, Internet Public Library.**

<http://www.ipl.org/youth/projectguide/>

**Science fairs, World Wide Web Virtual Library.**

<http://physics1.usc.edu/~gould/ScienceFairs/>

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New York: John Wiley & Sons.

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**Chicago, IL: University of Chicago Press.**

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New York: Modern Language Association of America.

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**Wired Style: Principles of English Usage in the Digital Age** (rev. ed.)  
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Chicago: University of Chicago Press.

Walker, J. R. and T. Taylor. 1998

**Columbia Guide to Online Style**  
New York: University Press.